

REMARKS

This communication is a full and timely response to the aforementioned non-final Office Action dated June 28, 2006. By this communication, Claim 1 has been amended. Claim 1 incorporates the features of cancelled Claim 18. Claim 6 has also been cancelled. New Claims 29 and 30 have been added. Support for Claims 29 and 30 can be found in cancelled Claim 6. No new matter has been added. Claims 1-3, 7, 9, 10, 12-17, 19-25, and 27-30 are pending.

Claim Rejection - 35 U.S.C. §112, ¶2

Claim 6 was rejected under 35 U.S.C. §112, second paragraph. Applicants have cancelled Claim 6, and thus the rejection is moot.

Claim Rejections - 35 U.S.C. § 102

Claims 1, 9, 10, 12, 13, 19, 20, and 27 were rejected under 35 U.S.C. §102(e) as allegedly anticipated by Hsieh et al. (U.S. Patent No. 6,607,675) ("Hsieh"). Applicants respectfully traverse this rejection.

As stated in MPEP § 2131, "[a] claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). For the following reasons, Hsieh fails to anticipate any one of the rejected claims.

Claim 1, as amended, recites a process for etching a low-k dielectric layer with selectivity to an overlying mask layer, comprising *inter alia*, supplying an oxygen-free single-fluorocarbon etching gas to the chamber and energizing the

etching gas into a plasma state, the etching gas consisting essentially of N₂, C₅F₈, and optional carrier gas, wherein a flow ratio of C₅F₈ to the N₂ is 3 to 7% (emphasis added).

Applicants respectfully submit that each and every element as set forth in independent Claim 1 is not found in Hsieh. The features of dependent Claim 18 (currently cancelled) have been incorporated into independent Claim 1 and Claim 18 was not rejected under this ground of rejection. As such, Applicants respectfully request the withdrawal of the rejection of Claim 1 under 35 U.S.C. §102(e). Dependent Claims 9, 10, 12, 13, 19, 20, and 27 are also patentable over Hsieh for at least the same reasons as those discussed above regarding Claim 1.

Claim Rejections - 35 U.S.C. § 103

A. Claims 2, 3, 6, 7, 14-17, 21, and 25

Claims 2, 3, 6, 7, 14-17, 21, and 25 were rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Hsieh in view of Jiang et al. (U.S. Patent No. 6,455,411) ("Jiang"). Claim 6 has been cancelled. Applicants respectfully traverse this rejection.

The Official Action acknowledges that Hsieh does not disclose the claim features of dependent Claims 2, 3, 7, 14-17, 21, and 25 and Jiang has been cited for allegedly disclosing these claim features (Official Action at page 4 to page 5, line 9). However, Jiang fails to cure the above-described deficiencies regarding Hsieh, recited in Claim 1. The features of dependent Claim 18 (currently cancelled) have been incorporated into independent Claim 1 and Claim 18 was not rejected under this ground of rejection. Accordingly, Applicants submit that Claims 2, 3, 7, 14-17,

21, and 25 are patentable over the applied references at least for the same reasons as Claim 1.

B. Claim 18

Claim 18 was rejected under 35 U.S.C. §103(a) as being unpatentable over Hsieh in view of Kim et al (U.S. Patent No. 6,159,792) ("Kim"). Applicants respectfully traverse this rejection.

As stated in MPEP § 2143, to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify a reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim features. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). The mere fact that references can be combined or modified does not render the resultant combination obvious unless the references also suggest the desirability of the combination. *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). 1596 (Fed. Cir. 1988).

As discussed above, Claim 1, as amended, includes the features of cancelled Claim 18. Claim 1 recites a process for etching a low-k dielectric layer with selectivity to an overlying mask layer, comprising *inter alia*, supplying an oxygen-free single-fluorocarbon etching gas to the chamber and energizing the etching gas into a

plasma state, the etching gas consisting essentially of N₂, C₅F₈, and optional carrier gas, wherein a flow ratio of C₅F₈ to the N₂ is 3 to 7% (emphasis added).

The Official Action acknowledges that Hsieh does not teach using N₂ and therefore does not teach an etchant consisting essentially of C₅H₈, N₂ and Ar; Kim is cited to allegedly cure this deficiency of Hsieh (Official Action at page 5). Moreover, the Official Action states that it would have been obvious to one skilled in the art to replace the C₅H₈/NH₃/Ar etchant of Hsieh with the C₅H₈/NH₃/Ar etchant of Kim because Kim teaches the "functional equivalence" of these two etchant mixtures (Official Action at page 5). Applicants respectfully disagree and submit that the two etchants are not disclosed by Kim as being functionally equivalent and the references also provide no motivation or suggestion of modifying Hsieh as proposed in the Official Action.

Hsieh discloses a "source gas comprising NH₃ and C_xF_y" (column 3, line 67) and states that "the ammonia (NH₃) gas portion of the plasma source gas functions to 'clean up' deposited polymer on the photoresist surface, on the etched surface, and on the process chamber surfaces" (column 2, lines 26-29). In other words, Hsieh discloses that the function of the ammonia is to reduce polymer deposits. In contrast, Kim discloses that "in order to [increase] the etch rate between the interlayer insulating layer **15** [BPSG or PSG] and the underlying etch stop layer **14** [silicon nitride], N₂ or NH₃ gas is added in the fluorine gas etchants" (column 3, lines 62-65). In other words, Kim discloses that N₂ gas functions to increase the etch rate between BPSG or PSG and silicon nitride. As such, Applicants respectfully submit that the two etchant mixtures are not functionally equivalent because Hsieh discloses that NH₃ functions to reduce deposited polymer while, in contrast, Kim discloses that

N₂ gas functions to alter etching rates. Thus, the Official Action fails to establish that N₂ is functionally equivalent to NH₃ in Hsieh's process. As N₂ and NH₃ have not been shown to be functionally equivalent, it is submitted that a person of ordinary skill in the art would not have been motivated to replace ammonia with nitrogen in Hsieh's process.

Because a *prima facie* case of obviousness has not been established, Applicants respectfully submit that the combination of features in Claim 1 are patentable over the applied combination of references.

C. Claims 22, 23, and 28

Claims 22, 23, and 28 were rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Ito et al. (U.S. Patent No. 6,753,263) ("Ito"). Applicants respectfully traverse this rejection.

Claims 22 recites a process for etching a low-k dielectric layer with selectivity to an overlying mask layer, comprising *inter alia*, etching exposed portions of the low-k dielectric layer with the plasma so as to etch openings in the low-k dielectric layer with the plasma while providing a etch rate selectivity of the etching rate of the low-k dielectric layer to the etching rate of the mask layer of at least about 5 (emphasis added).

The Official Action contends that it would have been obvious to use a total C₄F₈ and CF₂H₂ flow rate that is 30% or less than the N₂ flow rate in Ito's process because Ito discusses the addition of N₂ within the context of including additives such as Ar and that it is considered obvious to optimize process conditions such as

flow rates (Official Action at page 6, lines 8-12). However, Applicants respectfully disagree and submit that Ito does not teach or suggest all the claim features.

Ito discloses that "an SiO₂ film layer **208** is formed over the SiN_x film layer **206**" (column 6, lines 20-22; Figure 2) and that SiO₂ film layer **208** is the etched layer (column 7, lines 24-35; Figure 2). In other words, Ito discloses that silicon nitride film **206** is an underlying layer relative to silicon oxide film **208**, rather than an overlying mask layer, as recited in Claim 22. Ito further discloses that "SiN_x film layer **206** prevents the gates **202** from becoming etched during the formation of contact holes **210** (column 6, lines 15-17)." In other words, Ito discloses that silicon nitride film layer **206** is a protective etch stop layer for gates **202**, rather than an overlying mask layer. As such, Applicants respectfully submit that Ito does not teach or suggest all the claim features. Because a *prima facie* case of obviousness has not been established, Applicants respectfully request the withdrawal of the rejection of Claim 22 under 35 U.S.C. § 103(a). Dependent Claim 23 is also patentable over Ito for at least the same reasons as those discussed above regarding Claim 22.

Claim 28 depends from Claim 22 and thus is also patentable over Ito for at least the same reasons as those for which Claim 22 is patentable. Moreover, Claim 28 recites that the doped glass low-k material is carbon-doped. The Official Action contends that Ito teaches a carbon doped low-k dielectric below a Si₃N₄ (Official Action at page 6, lines 1-2). However, Ito discloses a SiO₂ film layer and an underlying silicon nitride layer, as discussed above regarding Claim 22. Moreover, Applicants respectfully submit that Ito provides no disclosure of a carbon-doped glass low-k material. Ito only discloses that "SiO₂ film **208** may be constituted of BPSG (silicate glass constituted of boron and phosphorus), PSG (silicate glass

constituted of phosphorus), TEOS (tetra-ethoxy ortho-silane), Th-OX (thermal oxide) or SOG" (column 6, lines 20-26). As such, Applicants respectfully submit that Ito does not teach or suggest all the claim features of Claim 28.

D. Claim 24

Claim 24 was rejected under 35 U.S.C. §103(a) as being unpatentable over Ito in view of Ku et al. (U.S. Patent No. 6,184,119) ("Ku"). Applicants respectfully traverse this rejection.

The Official Action acknowledges that Ito does not teach using a dual frequency reactor and cites Ku to allegedly cure this deficiency (Official Action at page 6, lines 15-17). However, Ku fails to cure the above-described deficiencies regarding Ito, recited in Claim 22. Accordingly, Applicants respectfully submit that Claim 24 is patentable over the applied references for at least the same reasons as those discussed above regarding Claim 22.

Conclusion


Based on at least the foregoing amendments and remarks, Applicants respectfully submit that all pending Claims 1-3, 7, 9, 10, 12-17, 19-25, and 27-30 are allowable, and this application is in condition for allowance. Accordingly, Applicants request a favorable examination and consideration of the instant application. Should the Examiner wish to discuss this application, Applicants request that the undersigned be contacted at the number below.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date: August 10, 2006

By:

A handwritten signature in cursive script, appearing to read "Eric Chen", written over a horizontal line.

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